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THE PROPOSED USE OF SINGLE, LETHAL SODIUM MONOFLUOROACETATE (1080) BAITS AS A MEANS OF REDUCING LIVESTOCK AND WILDLIFE LOSSES TO COYOTES

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INTRODUCTION

The impact of predation, primarily by coyotes (Canis latrans), upon domestic livestock and game animals such as deer (Odocoileus sp.) and antelope (Antilocapra americanas) has generated considerable controversy among livestock producers, game managers, wildlife researchers, and a wide variety of concerned citizens. The controversy has encompassed intensely emotional issues, primarily associated with differing philosophies toward the predator control or livestock damage abatement aspects of the question. It has also included extensive efforts to evaluate the magnitude of the problem in geographic as well as economic relationships.

Considerable data regarding predator-prey relationships and coyote behavior have been accumulated by researchers throughout the United States. Many questions involving the how, when, where, and why of coyote predation upon domestic and wild animals have been investigated and some conclusions have been reached. But many unknowns still exist and much more research is needed involving livestock and wildlife management techniques, and the objectives and methodology of predator control.

The Predator Problem in Montana

The predator problem in Montana cannot be accurately assessed merely in terms of total numbers of livestock lost to predators or as projected sheep or calf loss rates accompanied by representative dollar values. The predator problem is more than simple statistics. The reaction of livestock producers and wildlife preservationists to various aspects of this issue frequently touch upon complex emotional concerns that are difficult, if not impossible, to quantify. In the wake of recent intensive research efforts, the predator problem is more accurately viewed as an interdisciplinary consideration, affecting wildlife managers, land use planners, vertebrate pest control specialists, and many other concerned individuals as well as livestock producers.

Within Montana, which varies widely in topographical and environmental conditions, the predator problem also varies widely according to location and time of year, and in degree and duration of intensity. The detrimental impact of predator losses on wildlife or livestock populations varies substantially according to the size and vigor of the animal population sustaining the losses. A loss of 10 lambs, for example, from a total population of 1,000 lambs, represents only 1 percent of the flock. The same lambs, however, removed from a population of 100 lambs, now represents a 10 percent loss. The practical application of such an example becomes apparent when comparing a large, broad-scale sheep producer to a small, farm-flock operator. A predator loss of 10 lambs to a large producer may represent only a minimal concern. To a small, farm-flock operator, however, this same loss may constitute the difference between making or losing money on his investment at the end of the year.

Within Montana wildlife populations, the predator problem also varies widely according to location and time of year, and in degree and duration of intensity. A healthy deer herd of 100 animals may be able to sustain a predator loss of 10 individuals with little or no adverse effect, and perhaps even be a beneficial influence on the survivorship of the remaining animals. This same loss of 10 animals from a herd of 50 deer, however, in combination with other forms of natural mortality, may have a severely detrimental impact on the year to year size of the remaining herd, and certainly cuts into the number normally available to the hunter.

In recent years, investigations in Montana have evaluated the impact of predation upon the livestock industry and to a lesser extent upon wildlife populations. The coyote has been the most important predator involved in livestock depredations (Seyler 1973). Between 1967 and 1969, the Montana Crop and Livestock Reporting Service, in cooperation with the Montana Department of Livestock, conducted surveys in Montana to evaluate all forms of mortality which affect sheep production. Losses to predators during the 3-year study amounted to 18.3 percent of the total loss attributed to all causes including: lambing complications, old age, predation, disease, parasites, bloat, theft, inclement weather and poisonous plants. The predator loss totaled 170,000 sheep and lambs valued at $3,903,900 (Reynolds and Gustad 1971). From an analysis of the total sheep inventory in Montana during the 3-year interval (3,851,000 sheep and lambs), predation rates fluctuated from a low of 4.5 percent in 1967, to a high of 6.7 percent in 1968. This amounts to an average predator loss over the 3-year period of 5.6 percent (Seyler 1973).

Within Montana, the U.S. Fish and Wildlife Service, Animal Damage Control, maintains records of livestock losses to predators, representing only those depredations that are confirmed by their field personnel. Those losses, therefore, represent only a percentage of the total predator loss sustained by livestock producers throughout the state. During the 5-year period from 1969-1973, Fish and Wildlife Service personnel verified a loss of 14,000 sheep and 430 cattle to predators. The estimated value was $325,569 for the sheep and $49,105 for the cattle (Anonymous 1974).

During a recent intensive survey of sheep losses to predators without control, conducted on the Cook Ranch in southwestern Montana, coyote predation was identified as the primary factor affecting lamb survival (Munoz 1976). Modern production practices including shed lambing were utilized to minimize all forms of natural mortality. Despite these expensive, loss-preventive measures, coyotes killed more than 16 percent of the flock each year during a 2-year investigation. A total of 1,027 sheep was verified as coyote kills by research personnel. Coyotes were responsible for approximately 98 percent of the total predator loss recorded during the study (Munoz 1976).

Calendar year 1975 records of cattle and calf losses on 824 livestock operations situated throughout Montana indicated that coyotes contributed to the deaths of 236 adult cattle and 1,011 calves (Anonymous 1976). These losses occurred even though efforts to reduce and/or prevent depredations by coyotes were periodically undertaken using aerial hunting and a variety of other control measures. The magnitude of the loss undoubtedly would have been greater without the control efforts. These losses indicate that aerial hunting alone or in addition to other conventional control methods such as trapping, M-44's, call shooting, snares, and denning did not provide a solution to the predator problem.

Sheep production in Montana has declined at an alarming rate during the past decade. Between 1965 and 1976, for example, stock sheep numbers declined from 1.5 million head in 1965 to approximately 540,000 head in 1976 (Anonymous 1977). Some of the primary factors that have influenced the decline in sheep numbers not only in Montana, but throughout the 17 western states have been: predation, reduced market prices for lamb and wool, increasing production costs, lack of competent labor, and competition from synthetic fibers. (Gilbert 1976, Gee and Magleby 1976, Kilker and Disarte 1976, and Disarte and Sims 1974).

During the past two years, however, the market value of wool and lamb has increased. Greater interest among American consumers in natural fibers and increased production costs for synthetic fibers have been responsible for increases in the use of wool resulting in higher wool prices. The establishment of new international markets for high quality lamb and mutton has stimulated domestic sheep production and resulted in higher lamb prices for American producers (Gilbert Pers. Comm. 1976, and Kilker and Disarte 1976). These and other factors have produced a brighter picture for the American sheep industry. This condition should result in greater numbers of sheep being produced in Montana if techniques for reducing predator and other losses can be improved.

The impact of predation upon wildlife species has stimulated considerable interest on the part of game managers, hunters, wildlife preservationists, and other concerned individuals. In recent years, the Montana Department of Fish and Game and researchers at the University of Montana and Montana State University have assessed the impact of predation by coyotes on key big game species such as mule deer (Odocoileus hemionus), white-tailed deer (O. virginianus) and antelope.

Initial investigations on certain study areas indicated that predation by coyotes ranks high as a probable cause for the loss of many mule deer fawns during summer and autumn. Coyote predation caused substantial losses of fawn and adult mule and white-tailed deer on one study area during critical winter months (Schladweiler 1976). Mule deer doe:fawn ratios on one study area in the Missouri Breaks of Montana, for example, declined from a ratio of 162.5 fawns:100 producing females in June of 1975, to only 5.5 fawns:100 adults in March of 1976 (Schladweiler 1976). The most severe loss occurred between December 1975 and March 1976, when almost 74 percent of the remaining fawn crop and 44 percent of the total deer population on the study area were lost. Coyote predation was identified as the main cause of fawn and adult deer mortality during this time period (Schladweiler 1976).

Reichel (1976) found that antelope was an important part of the coyote diet during late May and June on the National Bison Range located in northwestern Montana. The highest levels of coyote predation on antelope were associated with attacks on antelope fawns located in close proximity to coyote dens. Coyotes were involved in the deaths of five of seven radio-tagged antelope fawns recovered by research personnel between July 1974 and July 1975. Coyote populations peaked on the Bison Range between 1973 and 1974, while antelope fawn survival declined to a 15-year low. Heaviest fawn losses occurred during the first 30 days after birth.

JUSTIFICATION

Sheep provide food and fiber for our nation and the world and are an important land-use management tool. Their relatively small size, diverse food habits, and foraging characteristics allows them to graze rugged rangelands that might otherwise be left unutilized. Sheep are efficient converters of forage resources to marketable red meat without the addition of grain supplements. In contrast, grain is normally required to prepare cattle, hogs, or chickens for market. The same cereal grains can then be used as direct human food supplies, resulting in more efficient utilization of these resources and the energy expended in their production. The efficient food conversion quality of sheep makes them a particularly vital asset in a world where no food supply can afford to be overlooked.

Deer and antelope hunting provides revenue, recreation, and meat for Montana residents and some non-residents. Deer and antelope populations are declining in some portions of the state and hunting regulations are becoming increasingly restrictive. Recent studies indicate that at least some of the decline in these wildlife populations is related to coyote predation. Whether for wildlife enhancement or livestock protection, it seems apparent that some forms of predator control may be desirable.

The predator problem continues in Montana despite a wide variety of predator control methods currently being employed to alleviate and/or eliminate damage problems. No single method of reducing or eliminating livestock and wildlife depredation problems has yet been found. Since an adequate solution is not yet available, the need for research to evaluate the efficacy of single, lethal 1080 baits in reducing and/or preventing livestock and wildlife losses to predators remains paramount.

Objections to 1080 as a tool in predator control have stemmed mainly from the method of delivering (the bait station) 1080 to the target animal. The proposed single, lethal 1080 bait is totally different. Therefore, in an evaluation of the single, lethal bait, the merits of the compound, sodium monofluoroacetate, and the merits of the single, lethal bait delivery system should not in any way be confused with, or compared to, historical use patterns associated with 1080 bait stations.

OPERATIONAL PROCEDURES

Study Areas

Study areas will be selected by the Project Guidance Committee (Refer to Appendix II), within the principal habitat types found in Montana. The research program will be divided into short-term and long-term studies, each conducted on separate land areas to assess different aspects of the livestock and wildlife (big game) depredation problems.

Short-Term Damage Abatement Studies

The short-term studies, of one-year duration, will include a series of damage abatement investigations. These investigations will be performed on a variety of habitat types and livestock operations. Both sheep and cattle producers, utilizing a diversity of rangeland conditions and differing in size and scale of operations will be sampled.

The primary objectives that will be evaluated during the proposed one-year duration of the short-term damage abatement investigations are:

1. Determine the effectiveness of single, lethal 1080 baits in reducing livestock or wildlife losses to coyotes.
2. Evaluate the use of single, lethal 1080 baits in coyote control with regard to human safety.
3. Assess the selectivity of single, lethal 1080 baits for coyotes in livestock and wildlife depredation areas with reference to nontarget species.
4. Evaluate the costs of utilizing single, lethal 1080 baits in livestock depredation areas.

Previous years' records of livestock and wildlife losses to coyotes will be obtained from the Montana Departments of Fish and Game and Livestock (Vertebrate Pest Control Bureau), in addition to the cooperating livestock producers. Prior to the introduction of any 1080 baits, losses will be documented until a loss pattern has been established. The documentation process will consist of field searches for and autopsy examinations of presumed predator kills as described by Nesse (1976) and Bouns (1976). By comparing the pre and post-treatment loss rates, an indication of the effectiveness of single, lethal 1080 baits in reducing and/or preventing livestock and wildlife losses to coyotes can be determined.

Baiting will be conducted only by research personnel and bait placement will be limited to lands where written permission from the owner, administrator, or leasee has been secured. Final selection of individual study areas will be made by the Project Guidance Committee (Refer to Appendix II). Single, lethal 1080 bait composition, preparation procedures, and placement rates will be discussed in a later section of this proposal.

No other forms of predator control (i.e., traps, M-44's, aerial hunting, etc.) will be permitted on study areas where single, lethal 1080 baits are in use. (Refer to Appendix I for discussion of alternative methods of predator control).

Bait placement and/or replacement will continue on individual study areas for as long as livestock or wildlife losses to coyotes persist during the actual study. Single, lethal 1080 baits will be retrieved from a study area following a 30-day cessation of all livestock or wildlife losses to coyotes.

Physiological markers will be investigated to determine their usefulness as indicators of bait consumption, when mixed with single, lethal 1080 bait materials. Laboratory autopsy research involving various physiological markers and other 1080 detection methods is currently underway at several state and federal research facilities around the United States (Balser pers. comm., 1976). Data pertaining to persistence in test animals, methods of detection, and cost of application will be assessed by the project leader and Project Guidance Committee, to determine if such procedures can be effectively and economically employed within the scope of this proposed research effort.

Target and nontarget animals found dead within the treated areas will be collected and sent to the Montana Department of Fish and Game or Montana Department of Livestock Research Laboratories in Bozeman, Montana for autopsy. Determination of cause of death may provide useful information in evaluating the impact of single, lethal 1080 baits on target and nontarget species.

Long-Term Coyote Population Control Studies

The long-term 3-year studies will include investigations to evaluate coyote population reduction as a means of reducing and/or preventing livestock or wildlife losses to coyotes. These long-term studies will incorporate both treated and untreated areas to measure the success of baiting operations.

Written permission will be obtained from all participating landowners, leasees, or administrators within the treated and untreated areas.

The primary objectives which will be evaluated during the proposed 3-year duration of the long-term, coyote population control studies are:

1. Evaluate the effectiveness of single, lethal 1080 baits in reducing coyote populations.
2. Determine the effectiveness of single, lethal 1080 baits in reducing livestock and wildlife losses to coyotes.
3. Evaluate the use of single, lethal 1080 baits in coyote control with regard to human safety.
4. Determine the most effective, selective, economical and environmentally safe delivery and/or placement procedures for single, lethal 1080 baits in domestic animal or wildlife depredation situations.
5. Assess the selectivity of single, lethal 1080 baits for coyotes in domestic animal or wildlife depredation areas.
6. Determine the optimum rates, placement locations, and seasonal applications of baits necessary to achieve desired local coyote population control.

Each treated area (one livestock study area and one wildlife study area), will be approximately 100 square miles in size. Untreated areas, corresponding in size and habitat condition with the treated areas, will be selected in order to provide comparative livestock and wildlife loss data for areas where no 1080 baits are in use. Study areas will be selected such that a distance of approximately 20 miles separates the outside perimeter of each area. Final selection of study areas will be made by the Project Guidance Committee. Primary considerations in study area selection will include: comparable vegetation and topography, similarity in livestock and wildlife composition, availability of livestock and wildlife production data, and variation in size and scale of livestock operations. No other forms of predator control will be permitted on the long-term study areas throughout the duration of the investigation.

In order to evaluate the status of coyote populations within the treated and untreated areas, coyote population censusing will be conducted utilizing scent post surveys, siren surveys, and aerial and ground counts. A comparison of these indices of predator abundance should indicate trends in the relative densities of coyotes inhabiting the study areas (Wolf 1973). Refer to Table 1, for all census schedules.

Samples of dead animals found in the treated study areas will be submitted for laboratory analysis. (Refer to previous section for discussion of laboratory autopsy). If physiological or other 1080 detection methods are found to be successful in identifying 1080 bait consumption by target or nontarget animals, these procedures will be further utilized during the coyote population control studies.

Livestock Study Area: One pair of study areas (one treated vs. one untreated), will be used to evaluate the effectiveness of single, lethal 1080 baits in reducing livestock losses to coyotes. An inventory of all livestock inhabiting the study area will be performed before any single, lethal 1080 baiting operations will be initiated. Periodic inventories of livestock utilizing the study area will be performed throughout the course of the investigation. (Refer to Table 1). The inventories will consist of lamb and adult sheep tallies during lambing, docking, shearing, and shipping. Cattle inventories will be performed during calving, branding, shipping and at other opportune times (i.e., gatherings for vaccinations, spraying, etc.).

Verification of presumed predator kills will be conducted by research personnel. Livestock producers will be reimbursed for all verified predator kills while single, lethal baits are in use. Previous years' records of livestock losses to predators and natural causes will be obtained from the cooperating producers. Specific searches for predator kills on the study areas will be conducted by research personnel as often as time and workload conditions permit, but no less than once per week.

The status of predator and prey populations will be determined by methods described in the following section.

Wildlife Study Area: Basic data concerning distribution, population trends, and sex and age ratios will be gathered for the big game species inhabiting treated and untreated areas. Aerial counts, marked animal counts, and fawn:doe and buck:doe ratios for deer and antelope, along with supplemental hunter harvest information should yield important statistics regarding the status of big game populations within treated and untreated areas. The use of any previous research and/or observational data available on the status of wildlife

Table 1. Annual Schedule for Wildlife and Domestic Animal Surveys on Treated and Untreated Single, Lethal 1080 Bait Study Areas. [1]

	SURVEY SCHEDULE FOR TREATED AND UNTREATED AREAS											
	Months											
SURVEYS	1	2	3	4	5	6	7	8	9	10	11	12
Document Losses [2]												
-Livestock	x	x	x	x	x	x	x	x	x	x	x	x
-Big Game	x	x	x	x	x	x	x	x	x	x	x	x
Coyote Censusing												
-Scent post lines (5-CD) [3]				x		x			x			
-Siren lines (3-CN) [4]		x		x		x			x			x
-Aerial counts (2-CD)		x		x		x			x			x
Predatory and Scavenging Mammals												
-Scent post lines (5-CD)				x		x			x			x
-Visual survey (3-CD) (3-CN)	x	x	x	x	x	x	x	x	x	x	x	x
-Aerial Counts (2-CD)	x		x			x			x			x
Predatory and Scavenger Bird Censusing												
-Visual survey (3-CD)	x	x	x	x	x	x	x	x	x	x	x	x
-Aerial counts (2-CD)	x		x			x	x		x			x
Big Game Censusing												
-Doe:fawn ratios (5-CD)			x			x				x		x
-Buck:doe ratios (5-CD)			x			x				x		x
-Marked animal counts (5-CD)			x			x				x		x
Population Inventory												
-Livestock	x		x			x			x			x
-Big Game [5]			x									x
Rabbit Censusing												
-Pellet transects (2-CD)	x				x				x			x
-Flush transects (2-CD)	x				x				x			x
-Roadside headlight counts (2-CN)	x				x				x			x
Rodents												
-Snap and live trap transects (3-CN)	x		x			x			x			x
-Activity Index Surveys (3-CD)	x		x			x			x			x

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1) Weather conditions may require that some segments of this schedule be modified.

2) Documentation of losses will be an ongoing effort performed by research personnel throughout the duration of this investigation.

3) CD = Consecutive days

4) CN = Consecutive nights

5) Includes aerial and ground counts conducted as soon as snow conditions warrant.

populations on the study areas will be requested from the respective state or federal agencies.

Rabbit population indices within treated and untreated areas will be obtained from pellet counts and roadside headlight counts along established transect lines (Schladweiler 1976). Daytime flush transects may also be used to determine population indices of both cottontail and jackrabbits.

Fisher, et al. (1947) described a roadside census method that will be used to assess population levels of predatory and scavenging birds and mammals. Permanent census routes will be established within treated and untreated areas.

Record (1977), Schladweiler (1976), and Nass and Hood (1969), recommend trapping of small rodents (Microtus and Peromyscus) as effective means of obtaining population indices. Periodic grid trapping (snap and live traps) of small rodents will be conducted to gather data on the composition, distribution, abundance, and availability of the rodent prey base accessible to coyotes.

Records of land-use patterns within the treated and untreated areas will also be maintained during the investigation. Such factors as livestock-use patterns, land-conversion activities, and herbicide, rodenticide, or insecticide-use rates will be monitored. Any one or a combination of these factors may influence the type and abundance of vegetative cover on rangelands within the study areas. Such fluctuations can directly affect the health and abundance of many forms of wildlife that inhabit the same rangelands. Any fluctuation in the abundance of prey species available to the coyote may in turn influence the feeding habits of these predators, resulting in potential increases or decreases in livestock and/or wildlife depredations.

All of the data collection processes described above will provide information useful in analyzing the relationship between coyote population levels and those of their wild and domestic prey. Data collection will continue throughout the duration of the study.

BAIT ACCEPTANCE

Bait acceptance by various predators has been studied very little. Johnston (1976) reported consumption of 81 percent of small, hamburger ball baits by red foxes, skunks, and coyotes within 14 days of exposure and noted that bait acceptance continued up to 42 days. Linhart, et al. (1968) determined rates of tallow bait acceptance by coyotes on study areas in Texas, New Mexico, and Arizona were between 28 and 34 percent of baits placed following a single, bait application. Johnston (1976) reported bait acceptance rates by coyotes in Ontario, Canada at between 49 and 68 percent of the coyote population present in baited areas. These data suggest that coyotes may locate small, perishable baits introduced within their home range.

To evaluate rates of bait acceptance by coyotes and non-target birds and animals, small, perishable, non-toxic baits containing a marking agent (i.e., non-lethal blood marker) will be placed on the untreated area during the final stages of the long-term investigation. Research directed by the U.S. Fish and Wildlife Service is currently underway in the Rawlins, Wyoming area to evaluate the properties and effectiveness of several promising marking agents. (Balser pers. comm. 1976). The results of this research may provide valuable information to be used in the selection of a specific marking agent suitable for the bait acceptance trials described above.

Placement rates and locations for 1080 baits will be similar to those used in the wildlife and livestock treated areas. Upon termination of the investigation, aerial hunting will be conducted by the state helicopter to collect as many coyotes as possible from the untreated area. Following laboratory analysis of these specimens, determination of bait acceptance may be identified by the presence or absence of the marking agent in the animal's blood. Using coyote population estimates obtained prior to termination of the investigation, a relative index of bait acceptance rates may be calculated.

Live trapping of certain nontarget species on the untreated area such as: foxes, badgers, bobcats, skunks and raccoons may also provide a relative index of bait acceptance by these animals. Blood samples, necessary to isolate the presence of the marking agent in the animal, will be obtained, thereby minimizing the sacrifice of nontarget animals.

Live trapping of raptors within the untreated area will be conducted according to procedures described by Ellis (1975) and Beebe and Webster (1964). Blood samples will be collected from the trapped birds to determine rates of bait acceptance by these nontarget species. The birds will then be released at the approximate location of capture.

1080 BAIT COMPOSITION, PREPARATION, AND PLACEMENT RATES

Single, lethal 1080 baits will be prepared under the supervision of the Project Leader. One Montana laboratory facility, selected by the Project Guidance Committee, will be used to prepare all bait materials. All applicable state and federal regulations and precautions regarding the handling of toxic materials will be strictly followed. (Refer to use precautions, Appendix III).

Each single, lethal 1080 bait will contain 3.6 mg. of sodium monofluoracetate. This amount is less than the suggested minimum, single dose rate of 5.0 mg. of 1080 per bait by the ASTM, assuming a maximum coyote body weight of 25 kg. Since most coyotes in this area weigh less than 18 kg. (approximately 40 lbs.), a reduced dose of 3.6 mg. per bait should be adequate.

Each 1080 bait will weigh approximately 15 grams and may be made from ground or rendered lard, tallow, or other animal matter. An inactive dye which does not cause aversion in the target species, such as nigrosene black or gentian violet, will be added to the 1080 concentrate to ensure thorough mixing in the bait preparation process and to identify toxic bait material (Anonymous 1976, and Anonymous 1967). Food scents attractive to coyotes may be added to the baits to enhance their acceptance (Anonymous 1976).

Placement of baits will be conducted only by the Project Leader or by research personnel supervised by him. Written records will be kept of all placement locations, date of placement, number of baits placed, date baits checked, consumption of baits by target or nontarget animals, environmental effects on baits, dates baits retrieved and destruction of baits.

Actual bait placement locations will be determined by research personnel and will include such locations as: livestock or wildlife kill sites, coyote travel trails, scent posts, den sites, or other "draw" stations. A maximum of two baits will be placed at a single placement location and use rates shall not exceed 10 single, lethal baits per section (640 acres). Bait placement locations will be situated at least ¼-mile apart.

The soil around selected bait placement sites will be utilized in such a fashion that a 3-foot diameter surface will be available to record the "track" impressions left by any animal investigating and/or consuming the bait. During the winter, animal tracks left in the snow within a 3-foot diameter of selected baits will also be recorded.

Selected placement of 1080 baits will be an important means of reducing the hazards to nontarget species. Nesse and Seyler (1975) report that careful placement and concealment of M-44's in primary coyote habitat locations represented the most selective and efficient means of taking target animals, while minimizing the exposure hazard to nontarget species. In order to reduce consumption of 1080 baits by scavenging birds, baits will be placed under natural coverings such as small, flat stones, cow chips, vegetative debris, or other natural materials.

Within 10 feet of each single, lethal 1080 bait, a stake warning sign, elevated at least 15 inches off the soil surface, will be positioned in such a manner that it is visible from all angles and includes an identification arrow and/or marker that designates the exact location of each bait.

Baits shall be checked at least once every 7 days by research personnel. The total period of exposure for unconsumed baits at a specific placement location shall not exceed 30 days. Baits that are not consumed within 30 days shall be retrieved by research personnel and the placement location abandoned. As long as 1080 baits are consumed by target animals or as long as livestock or wildlife depredations persist, the baits shall continue to be replaced.

Considering the proposed 100 square-mile size of each of the two long-term coyote population control treatment areas, a maximum of 1,000 single, lethal baits (10 per section x 100 sections), could be present on each treated area at any given time during the investigation. Assuming an average replacement rate of each bait every 30 days, a total of 12,000 baits (1,000 baits x 12 months per year), could be used on each treated area during the year. Since there are 2 treated areas, the combined total would be 24,000 baits per year. During the proposed 3-year duration of the investigation, the total could potentially reach 72,000 baits. At a dose rate of 3.6 mg. of 1080 per bait, the maximum amount of 1080 that could be used would be 259,200 mg. or 259.2 grams.

Assuming that the combined land areas used during the short-term, damage abatement studies to be roughly equivalent to the size of one of the coyote population control study areas (100 square miles), the maximum number of baits that could potentially be used during the proposed 1-year duration of this investigation would also be 12,000 baits. At a dose rate of 3.6 mg. of 1080 per bait, the actual amount of 1080 that could be used would be 43,200 mg. or 43.2 grams. Combining the projected amounts of 1080 required for both short and long-term investigations, the combined total would be 302.4 grams (approximately 0.6 pounds). This combined total represents only an estimate, and may be subject to revision according to changes in the size of study areas or bait replacement.

Baiting Restrictions for Endangered and Threatened Species

No single, lethal 1080 baits will be placed in areas where black-footed ferrets (*Mustela nigripes*), wolves (*Canis lupus*), or grizzly bears (*Ursus horribilis*) have been seen or otherwise identified by the presence of tracks or other distinctive "sign".

Antidote and First Aid Considerations for 1080 Poisoning

Although there are no human cases of 1080 poisoning due to predator control uses, a potential health hazard exists and the following discussion identifies hazards and prescribes measures to prevent accidental exposure.

The sodium monofluoroacetate lethal dose range for man is between 0.5 and 2 mg./Kg., (Fike and Pattison 1959). Therefore, a 150-pound adult requires at least 34 mg. of the toxicant to receive a potentially lethal dose. With 1080 concentration levels of 3.6 mg. per single, lethal bait described earlier, a 150-pound adult would have to consume at least 10 of the baits to receive a potentially lethal dose.

The potential hazard of 1080 poisoning in humans has precipitated research efforts around the world to develop a successful antidote for 1080 poisoning. Investigators including Noguchi et al. (1968), Pattison (1959), Chenoweth et al. (1951), Tourtellotte and Coon (1951), and Thomas (Pers.Comm. 1975) have evaluated many compounds and treatment procedures. Pattison (1959), for example, discovered that monoacetin (glyceryl monoacetate), acetamide, and combinations of sodium acetate and ethanol all show some therapeutic effects in monkeys and other animals. The protective action of both monoacetin and acetamide is due to the liberation of active acetate (acetylcoenzyme A) for competition with the toxic material, 'active fluoroacetate'.

Noguchi et al. (1968) used acetamide effectively to eliminate mortality in rats and guinea pigs after injecting them with a lethal dose of monofluoroacetate. Effective treatment procedures involved intra-muscular injection rates of 300 mg. of acetamide per kilogram of animal body weight, three times per day over a five-day period.

Chenoweth et al. (1951) found monoacetin to be an effective antagonist to fluoroacetate (0.1 mg./Kg.) poisoning in the dog, provided that enough monoacetin be given over a sufficiently lengthy treatment period.

More recently in Japan, humans poisoned by 1080 have recovered after an acetamide treatment involving dose rates between 30 and 100 grams of acetamide administered per day (Thomas Pers. (Comm. 1975). A 50 percent (W/V) water solution of acetamide was prepared using extra pure reagent. The solution was then packed in 50 ml. ampules that were added to a dextrose solution and administered intravenously to the patient (Thomas Pers. Comm. 1975). These cases of 1080 poisoning resulted from consumption of 1080 treated rodent baits.

Additional first aid that should be administered to anyone consuming sodium monofluoroacetate consists of immediate emesis and gastric lavage followed by an oral dosage of magnesium or sodium sulphate to remove the chemical from the alimentary tract and prevent absorption of a lethal amount (Anonymous 1976). The patient should then be kept quiet and transported to a hospital where barbiturates may be administered to control convulsions.

First aid instructions will be made available to all research personnel involved with the proposed research projects. Local hospitals within a 100-mile radius of the proposed study areas will be advised of treatment materials and procedures. Poison control centers in Great Falls, Helena, and Bozeman, Montana will also be advised to have materials available to treat accidental cases of 1080 poisoning. The Montana State Department of Health will coordinate the distribution of antidote materials and treatment procedures to local hospitals in the study areas and to the poison control centers (Skinner Pers. Comm. 1977).

PROPERTIES OF SODIUM MONOFLUOROACETATE

Sodium monofluoroacetate is a white, crystalline, essentially odorless, hygroscopic, fluoroorganic salt (Anonymous 1976), and (Atzert 1971). The pure compound is described as having a mildly salty, sour, or vinegary taste. It is highly water soluble, but relatively insoluble in organic solvents such as kerosene, alcohol, or acetone and in animal and vegetable oils and fats (Anonymous 1976).

Monofluoroacetic acid (FCH_2COOH) was first chemically synthesyzed in Belgium at the end of the nineteenth century. The toxic nature of this organofluorine compound was not fully understood, however, until the early 1930's. Pattison (1959) reported that the FCH_2COO ion of monofluoroacetic acid is responsible for the compound's toxicity. He also reported that there is a wide variation between species in responses to the presence of this compound in the body (Pattison 1959).

Organofluorine compounds, such as sodium monofluoroacetic acid, are naturally occurring in the wild (Pattison 1959), and Marais 1944). The FCH_2COO ION contained in the poisonous plant known as gifblaar, for example, (Dichapetalum cymosum) is the same toxic agent found in sodium monofluoroacetic acid (Pattison 1959). In the case of gifblaar, only 3/4 ounce of leaves is lethal to a goat. Several other poisonous plants containing monofluoroacetic acid are found in nature including Acacia georginae and Gastrolobium grandiflorum, both found in Australia (Atzert 1971).

Sodium monofluoroacetate was first used in vertebrate pest

Characteristics of Sodium Monofluoroacetate

1.	Name	Sodium Monofluoroacetate
2.	Formula	FCH_2COONa
3.	Physical State	Solid (crystalline powder)
4.	Color	White
5.	Odor	Odorless
6.	Taste	Mildly salty, sour, or vinegary taste
7.	Melting Point	110° C.
8.	Decomposition Point	200° C.
9.	Absorbtivity	Absorbed through the gastrointestinal tract, open wounds, mucous membranes and pulmonary epithelium. Not readily absorbed through intact skin.
10.	Reactivity	In vivo, fluorocitrate synthesyzed from sodium monofluoroacetate. Fluorocitrate inhibits citric acid cycle and blocks citrate and succinate metabolism. Increased citrate secondarily inhibits energy production by blocking glucose metabolism.
11.	Deliquescence	Non-deliquescent
12.	Solubility	Highly soluble in water, but relarively insoluble in organic solvents such as kerosene, alcohol and acetone, and in animal and vegetable oils and fats.

control in the United States after World War II as a rodenticide. Since the U.S. Fish and Wildlife Service has been the primary federal agency responsible for vertebrate pest control within the United States, the research data collected by European and American scientists prior to and during World War II, were turned over to Fish and Wildlife Service personnel. It was at this time that the compound was assigned the code or identification number 1080 (Robinson 1958).

Research by the Fish and Wildlife Service with compound 1080 continued during the mid 1940's, at which time a high degree of specificity towards members of the dog family (Canidae) was discovered (Wagner 1972, and Gier 1968). Compound 1080 was first used as a predacide in 1947 (Robinson 1947).

Mode of Action

Upon ingestion, sodium monofluoroacetate is converted in vivo to fluorocetric acid (Pattison 1959, and Elliott and Kolnitsky 1950). The fluorocetric acid is a metabolite of monofluoroacetate and acts to block citrate and succinate metabolism within the citric acid, or Krebs cycle (Pattison 1959, and Peters 1952). The inhibition of this metabolic process results in a loss of energy production necessary to maintain body function. Elliott and Kolnitsky (1950) report that this energy deprivation leads to impairment of cellular function, destruction of cell permeability barriers, and ultimately, death.

The 1080 poisoning latent period, that time from consumption until symptoms occur, is a necessary time product resulting from the lethal biochemical synthesis of fluorocitrate underway within the organism (Pattison 1959). This process includes: absorption and translocation of 1080 through the gastrointestinal tract, open wounds, mucous membranes, or pulmonary epithelium and then cell penetration. Once cell penetration occurs, time is required for the synthesis of a lethal quantity of fluorocitrate. After this is complete, the fluorocitrate begins to disrupt intracellular function and clinical symptoms begin to occur (Atzert 1971, and Pattison 1959).

Research conducted by Fish and Wildlife Service investigators indicated that even after administering more than five times the necessary lethal dose to test coyotes, the time required from bait consumption until death was not reduced below 1½ hours (Anonymous 1946 and 1945). Within this time span, the period of lethal symptoms varied from 20 to 30 minutes.

The major body functions reacting to 1080 poisoning may either be the central nervous system or the heart, with death resulting from: respiratory arrest following severe convulsions, gradual cardiac failure or ventricular fibrillation, or progressive depression of the central nervous system with either respiratory or cardiac failure as the final event (Elliott and Kolnitsky 1950).

Compound 1080 residues within the body are most concentrated within the liver, kidneys, heart, spleen, intestines, and stomach (Atzert 1971). Tests indicate that 1080 is not cumulative and in instances where sublethal amounts were ingested, most victims recovered completely, and 1080 residues disappeared within a few days (Foss 1948, and Robinson 1947). This latter observation suggests that the lethal enzyme fluoroacetate unions do break down and that detoxification occurs within the body through excretion in the urine and/or feces. Fluoroacetate residues were detected in the urine of rats after administration of sodium monofluoroacetate (Atzert 1971).

Cold blooded vertebrates are generally considered insensitive to fluoroacetate poisoning (Atzert 1971, and Chenoweth 1949). King and Penfound (1946) determined that fish are generally unaffected by fluoroacetate dissolved in the water in which they live. These observations suggest that minute quantities of sodium monofluoroacetate that might enter waterways as a result of environmental decomposition of single, lethal 1080 baits, would pose a minimal exposure hazard to fish populations within these waters.

Effectiveness

There has been no information gathered on the effectiveness of single, lethal 1080 baits in reducing and/or preventing livestock and wildlife depredations by coyotes. What information has been collected on the effectiveness of 1080 as a predacide was primarily gathered by researchers investigating the effectiveness of 1080 bait stations in reducing sheep losses to coyotes. Data collected by Robinson (1948, 1947 and 1946) indicated that following the utilization of 1080 bait stations on various western sheep ranges, extreme reductions in coyote depredations on sheep, ranging from 75 to nearly 100 percent, were recorded. Wagner (1972) compared records of sheep losses to predation from several states before and after 1080 was in use and concluded that a correlation exists between coyote population densities and levels of sheep losses. In light of this correlation, he reported that methods of generalized coyote population reduction may result in decreased levels of sheep losses to coyotes.

The removal of individual livestock killing coyotes may also result in reductions in livestock losses (Nesse 1973). The rapid and efficient removal of the troublesome individual becomes critically important. Effective single, lethal 1080 bait placement in these instances may be an effective and efficient means of reducing livestock losses.

Selectivity

As cited earlier, compound 1080 was found to be acutely toxic to members of the dog family, while most other species require proportionately larger quantities of the material to receive a lethal dose (Wagner 1972, Atzert 1971, and Gier 1968). This inherent characteristic of sodium monofluoroacetate was what prompted its use as a predacide nearly 30 years ago. In the interim, a great deal of factual and fictitious information has come to light regarding both real and imaginary environmental hazards associated with its use. One of the main controversial issues has centered on the exposure hazard of 1080 to nontarget species.

As a point of reference, the 1080 bait station delivery technique involved dissolving a given quantity of 1080 concentrate into a given volume of water. The solution was then applied in most cases directly into the flesh of a bait station carcass (i.e., horse, sheep, or other livestock), using a hypodermic syringe (Robinson 1948). As a toxicant for coyote control, the use of only 1.6 grams of 1080 per 100 pounds of station meat, cut and distributed in 50 to 100-pound bait stations, made small quantities of the bait lethal to coyotes, but relatively safe for most other species (Robinson 1948). The station baits were generally placed at distribution intervals of approximately one bait station per 36 square miles (Cain et al. 1972, and Atzert 1971). This placement rate was utilized to reduce exposure hazards to nontarget furbearers such as fox, bobcat, and raccoon (Robinson 1958, 1953, and 1952a).

Even though extensive efforts were implemented to reduce the poisoning hazard to nontarget species, several investigators, including Wagner (1972), Evanson (1967), and Robinson (1952b), have reported that other animals including bobcats, martens, mink, foxes, raccoons, golden and bald eagles, and magpies are susceptible to 1080 poisoning. LD_{50} data collected for these species indicate that in most cases their susceptibility to 1080 is considerably less than the coyote; however, the quantities of 1080 available to them within a 1080 bait station created a potential hazard.

The primary selectivity advantage of the single, lethal 1080 bait is the limited amount of sodium monofluoroacetate available to the animal consuming the bait. Table 2 indicates the number of single, lethal 1080 baits, treated with 3.6 mg. of sodium monofluoroacetate, that certain nontarget species would have to consume in order to receive a potentially lethal dose.

As mentioned by Beasom (1976) and Robinson (1961, 1952b), the more restricted movements and home range of many nontarget species reduces the possibility of their coming in contact with 1080 baits. Storm et al. (1976) estimated the home range for the red fox at between 3.5 and 4 square miles. Tagging studies conducted in Montana by Robinson and Grand (1958), revealed that bobcat movements were considerably less than coyotes and data suggested an approximate home range of between 10 and 12 square miles for this furbearer. Recent coyote home range data gathered by Danner (1976), placed estimates at between 20 and 30 square miles. Based on home range size and susceptibility to 1080, these species could possibly be affected. Restricting bait placement to only prime coyote habitat locations, however, should reduce the likelihood of specific nontarget animals locating the baits.

Lindzey (1971) estimated the average home range of badgers to be approximately one square mile. Table 2 indicates that a badger would have to consume at least three single, lethal baits to receive a potentially lethal dose. Therefore, at distribution rates of no more than two single, lethal baits per placement location, it would be impossible for a badger to receive a lethal dose of 1080 by consuming both baits at one placement location. It is possible, however, that a badger could receive a lethal dose of 1080 if he located both baits at two separate placement locations. For this to occur in a short enough period of time seems unlikely due to rather restricted movement patterns of most badgers within their home range (Lindzey 1971). Considering these factors, the exposure hazard of single, lethal baits to individual badgers seems minimal and their potential detrimental impact on badger populations within proposed study areas would also appear very nominal.

The increased resistance to compound 1080 and comparatively limited movement patterns of porcupines and raccoons, should result

Table 2. Relationships Between Proposed Concentrations of Sodium Monofluoroacetate in Single, Lethal Baits to the Approximate Home Ranges of Several Important Non-Target Species. (1

Species	Approximate Home Range	Mg./Kg. LD_{50}	Average Wt. Kilograms	Number of 1080 Baits Containing 3.6 mg. 1080 to Receive LD_{50}
Coyote (Canis latrans	25 sq. mi.	0.1	18 Kg.	1
Red fox (Vulpes vulpes)	3.5-4 sq. mi.	<0.3	5.4 Kg.	1
Bobcat (Lynx rufus)	12 sq. mi.	<0.66	10 Kg.	2
Badger (Taxidea taxus)	1 sq. mi.	1.0-1.5	8.6 Kg.	3-4
Raccoon (Procyon lotor)	120 acres	2	11 Kg.	7
Marten (Martes americana)	300 acres	1.0	1.4 Kg.	1
Mink (Mustela vison)	50 acres	1.0	1.4 Kg.	1
Black Bear (Ursus americanus)	2 sq. mi.	0.5-1.0	136 Kg.	38-75
Porcupine (Erethizon dorsateum)	30-40 acres	<1.0	5 Kg.	2
Ground Squirrel (Citellus sp.)	---	0.9	0.5 Kg.	1
Kangaroo Rat (Dipodomys sp.)	---	0.1	<0.1 Kg.	1
Mice (Peromyscus sp.)	---	4.0	<0.1 Kg.	1
Prairie Dog (Cyonomys ludovicianus)	---	0.3	1.4 Kg.	1
Black-tailed Jack Rabbit (Lepus californicus)	---	5.5	.2 Kg.	3
Magpie (Pica sp.)	---	0.6-1.3	0.2 Kg.	1
Golden Eagle (Aquila chrysaetos)	---	1.25-5.00	3.2 Kg.	2-5
Hawks (Buteo sp.)	---	10.0	1.1 Kg.	3
Turkey Vulture (Cathartes aura)	---	20.0	2.7 Kg.	15

[1] Values taken from ASTM (1976), Atzert (1971) and Ward and Spencer (1947).

in a minimal exposure hazard to these species. As indicated in Table 2, the raccoon would have to consume seven baits to receive a lethal dose. Urban (1970) found the average home range for raccoons to be between 120 to 300 acres. At maximum baiting levels, of 10 baits per square mile, and assuming uniform placement distribution within the 640 acre area, no more than 5 or 6 baits would be available within the average home range of any one raccoon. According to these baiting levels, it would be highly unlikely that a raccoon would be able to locate and consume an adequate number of baits, in a short enough period of time to receive a lethal dose.

The porcupine also has a limited home range of only 30 to 40 acres (Marshall, Gullion, and Schwab 1962). Table 2 indicates that an average porcupine would have to consume at least two single, lethal baits to receive a potentially lethal dose. Bait placement rates of two baits per setting may present a sufficient exposure hazard for a porcupine to receive a lethal dose, if he were able to locate and consume both baits at a single placement location. Distribution rates of no more than 10 single, lethal baits per section, however, would appear to pose no serious hazard to the total porcupine population in any study area.

Hawley and Newby (1957) reported the average home range for an adult marten to be approximately 300 acres. As indicated in Table 2, a marten need consume only one bait to receive a potentially lethal dose. In order to minimize the exposure hazard to members of this species, Robinson (1952a) reported that compound bait materials could be placed safely within marten habitat by positioning the baits in large, open clearings at least 75 yards away from any protective vegetation. Robinson (1952a) observed that most martens were unwilling to venture into large clearings to consume 1080 treated bait materials. Robinson (1952a) also reported that marten populations were not adversely affected by the presence of 1080 bait stations, containing 100's of potentially lethal doses, within their preferred habitat.

Mink also possess a high sensitivity to monofluoroacetate (Table 2). An adult mink could receive a lethal dose of 1080 from only one bait. Their preferred habitat of riparian waterways and their limited home range of approximately 50 acres, however, greatly reduces the potential exposure hazard to this aquatic furbearer (Mitchell 1961). Robinson (1952a) reported that mink populations were not adversely affected when 1080 treated bait materials were situated at least ¼ mile away from water courses. Implementation of an exposure buffer when placing baits near mink habitat would appear to be an effective means of reducing the exposure hazard to this species.

Jonkel and Cowan (1971) found that the average home range for adult black bears in Montana comprises an area of 1½ to 2 square miles. A 136 kg. (300 lb.) black bear would have to consume at least 38 and more likely up to 75 baits to receive a potentially lethal dose (Table 2). At proposed distribution rates of no more than 10 baits per square mile, the maximum number of baits a bear could possibly find within his 2-mile home range would be 20. This represents only about half the minimum dose required to produce any adverse physical effects. The data suggest, therefore, that a minimal exposure hazard exists using single, lethal 1080 baits in black bear habitat.

The potential detrimental impact of single, lethal 1080 baits to rabbit and rodent populations within the proposed study areas is considered insignificant. The limited home range of these species and their high reproductive rate makes it extremely unlikely that a maximum, proposed baiting rate of two baits per setting and 10 baits per square mile would have any noticeable impact on these small mammal populations.

Concealment of single, lethal 1080 baits should minimize the possibility of bait discovery by predatory and scavenging birds. This precaution, in addition to the increased resistance of most birds to 1080 (Table 2), should result in a minimal exposure hazard to most bird species.

Robinson (1961) reported that populations of bobcats, badgers, skunks, raccoons and foxes all increased in numbers in areas where 1080 bait stations were used in predator control. The data presented in this section suggest that the use of single, lethal 1080 baits would produce little if any adverse effect upon the populations of most nontarget species. Monitoring their population levels, as proposed in this study plan, should reveal any significant changes up or down that may result from 1080 poisoning.

Secondary poisoning

Secondary poisoning hazards associated with compound 1080 have primarily resulted from the consumption, by "secondary" consumers, of sufficient amounts of poisoned target and nontarget animals to receive a lethal dose. Cain et al. (1972) reported that many of the secondarily poisoned nontarget animals had probably fed on carcasses of coyotes that consumed an excess of 1080 from a bait station carcass. Not only did this excess of 1080 bait consumed by coyotes result in their bodies (primarily stomach and digestive tract) becoming a hazard to nontarget scavengers, but the consumption of excessive quantities of 1080 often produced an emetic reaction by the poisoned animal that resulted in the random deposit of quantities of vomitus that contained lethal levels of 1080 for many nontarget species.

The critical issue of concern in this discussion involves the ingestion of excessive amounts of 1080 by the primary bait consumer. If the quantity of 1080 being consumed is adequate, but not in excess of the target animal's lethal dose requirement, then the secondary poisoning hazard might be greatly reduced. The single, lethal 1080 bait containing a small amount of sodium monofluoroacetate, is a possible solution to the secondary poisoning problem.

Important factors influencing the potential secondary poisoning hazard associated with the carcass of a coyote that has succumbed to 1080 toxicity from a single, lethal bait would include: rates of sodium monofluoroacetate metabolism within the body prior to death, excretion of fluorocitrate by the animal, and distribution of 1080 through the body organs prior to death (Anonymous 1976). Gal et al. (1961) found that rats were able to metabolize sodium monofluoroacetate into non-toxic metabolites and/or excrete a large amount of monofluoroacetate and fluorocitrate (nearly one-third of a 5.00 mg./Kg. dose of sodium monofluoroacetate excreted). Detoxification and/or excretion of 1080 has also been shown for other animals including dogs and rabbits (Foss 1948).

A reduction in the amount of 1080 remaining in the body of a coyote after consuming a bait containing only 3.6 mg. of sodium monofluoroacetate, would minimize secondary poisoning hazards. Since 1080 is most heavily concentrated within the internal organs of poisoned victims, a golden eagle, for example, would have to consume the viscera of two to five coyotes (assuming no detoxification or excretion) to potentially receive a lethal dose (Table 2). If, however, only minimal reduction in 1080 concentration occurred (i.e., approximately 30 percent through excretion as documented for rats by Gal et al. (1961), then an average 7-pound golden eagle would have to consume the viscera of three to seven coyotes to receive a potentially lethal dose. Atzert (1971) reported that the viscera of coyotes accounts for approximately 20 to 25 percent of their live weight, or 8-10 pounds. A golden eagle would, therefore, have to consume at least 24 pounds and quite likely up to 70 pounds of coyote viscera to receive a lethal dose. Since their daily consumption of food equals approximately 30 percent of their live weight, or about three pounds, a golden eagle would have to feed exclusively on coyote viscera for between 8 to 23 days (assuming no detoxification), to even remotely approach lethal dose levels (Atzert 1971). Needless to say, the likelihood of such an occurrence would be extremely rare at best. Atzert (1971) also reported that eagles do not accumulate sodium monofluoroacetate within their bodies.

Studies reveal that as the minimum lethal dose for canids is approached, vomiting becomes less frequent than with higher doses (Anonymous 1967). Tests utilizing single, lethal baits containing 3.4 mg. of 1080 indicated that 88 percent of test animals showed no emetic reaction after consuming the bait. All of the test animals died, with convulsions beginning no sooner than two hours after bait consumption and with death resulting no sooner than three hours after baits were ingested (Anonymous 1967).

These data suggest that baiting with single, lethal 1080 baits would present minimal secondary exposure hazards to nontarget animals from coyote vomitus. Even if vomiting did occur following a 1½ to 2-hour latent period after ingestion (in which time a lethal quantity of 1080 was absorbed from the stomach), it is doubtful that sufficient quantities of 1080 would remain in the vomitus to present a hazard to nontarget animals.

The above data indicate that single, lethal 1080 baits would present little if any secondary poisoning hazards to nontarget species. A tertiary hazard was never documented even when 1080 bait stations were in use. Considering the proportionately smaller amounts of 1080 available in single, lethal baits, the possibility of a tertiary poisoning hazard would appear to be very unlikely.

Biodegradation of Sodium Monofluoroacetate

The organic composition of single, lethal 1080 baits described earlier in this proposal will result in varying degrees of bait decomposition as influenced by climatic conditions. Such decomposition will result in small quantities (3.6 mg. of sodium monofluoroacetate per bait) of 1080 being deposited in the soil. Whether or not quantities of sodium monofluoroacetate in the soil will present a potential hazard to nearby plants or other components of the environment is a subject that has received considerable attention by investigators.

David and Gardiner (1966), Kelly (1965), Goldman (1965), and Horiuchi (1960) all report that sodium monofluoroacetate breaks down in the soil. Kelly (1965) isolated bacteria in the pseudomonad classification that are capable of oxidizing fluoroacetate. An enzyme within the bacteria catalyzes the liberation of the fluoride ion and glycolate from fluoroacetate (Goldman 1965). David and Gardiner (1966) reported that concentrations of fluoroacetate in the soil amounting to 50 ppm. were completely biodegraded within 11 weeks by soil microorganisms. By-products were glycolate and inorganic fluoride ions.

Goldman and Milne (1966) observed that self-degradation of fluoroacetate occurs in water resulting in a loss in toxicity. By-products of this degradation process were harmless sodium bicarbonate and methyl fluoride. Furthermore, Saito et al. (1966) monitored stream water in a sodium monofluoroacetate treated area for five months and did not detect even a trace of the toxicant in the water. The dilution factor associated with sodium monofluoroacetate residues in natural water sources also greatly minimizes any potential exposure hazard to any life form (Robinson 1958).

The above data suggest that any sodium monofluoroacetate deposited in the soil or water as a result of environmental decomposition of single, lethal baits, would be present in such dilute quantities and would be acted upon by soil microorganisms in such a fashion, that the compound would be reduced to harmless by-products in a relatively short period of time.

Translocation of Sodium Monofluoroacetate into Plants

David and Gardiner (1966) and David (1950) discovered that sodium monofluoroacetate can be absorbed by plants through their root system and leaves. Preuss and Weinstein (1969), however, found that plants contain an enzyme which decomposes monofluoroacetate by cleaving the carbon-fluoride bond.

The possibility of significant quantities of sodium monofluoroacetate becoming available in the soil as a result of environmental decomposition of single, lethal 1080 baits seems very unlikely. The wide distribution of baits within bait placement areas, the limited amount of sodium monofluoroacetate present in a single lethal bait (only 3.6 mg.), and processes of soil and water degradation acting upon the compound, would all tend to neutralize any potential exposure hazard to any form of plant or animal life. During 25 years of 1080 use in bait stations that contained hundreds of times more lethal doses than would be present in a single, lethal bait, no case of livestock or wildlife poisoning from 1080 translocation in plant tissue was ever recorded or even suspected (Anonymous 1970).

APPENDIX I

REVIEW OF PREDATOR CONTROL METHODOLOGY

The following discussion of predator control methods includes a description of all known and anticipated control procedures with a comparative evaluation of the advantages and disadvantages of each, based on the following criteria described by Evanson (1967).

1. Effectiveness: control technique should succeed in reducing depredations, etc.
2. Economy: cost of a control method must be reasonable.
3. Safety: control technique should not be dangerous to its handlers, to other humans, or to domestic livestock or wildlife.
4. Selectivity: the control method should not threaten non-target species.
5. Humaneness: although a nonquantifiable term, humaneness represents a desirable goal in the eyes of most people and should receive consideration.

Steel Traps

Trapping has been called the oldest profession (Fitzwater 1970). Ever since domestic animals first arrived in America, historical records indicate that trapping of carnivorous mammals was necessary.

Trapping methods have been described by many authors including Wade (1973), Fitzwater (1970), Gier (1968), Castro and Presnall (1944), and Young (1930). The most commonly used trap for coyotes has been the number 3-N trap with double springs and offset, smooth jaws. There are about as many different ways of making trap sets as there are individuals doing the trapping. In general, traps are placed at one (single set) or two (double set) per setting. They are attached by a short chain to a stake or drag.

Location for the setting is perhaps the single most important concern of the trapper. Skill in reading animal "sign" (tracks, location of scent posts, etc.) is essential for capturing troublesome coyotes. Careful location of trap sets can also minimize accidental captures of nontarget animals such as foxes, skunks, raccoons, or bobcats.

Weather can adversely affect steel traps and prevent them from springing when stepped on by an animal. They can become frozen in the ground, or mudded-in" after a rain. If buried in sand or very dry soil, wind can blow the covering material away leaving the trap exposed.

Traps are a commonly used method of predator control because they can be procured at a nominal expense and are easy to operate. Primary costs associated with trapping programs include the trapper's salary and travel expenses involved with checking traps regularly.

Traps are relatively safe to use in populated areas because dogs and livestock can be removed from them (Leopold 1964). Except for an occasional pinched finger, traps present little if any danger to the operator.

Several authors, including (Cain et al. 1972 , Evanson 1967, Leopold 1964, and Hey 1964), have criticized trapping for its lack of selectivity. Frequently taken nontarget animals include bobcats, badgers, domestic dogs, foxes, raccoons, skunks, and other smaller animals. Effective means of increasing the selectivity of trapping include: utilizing experienced and knowledgeable individuals in control operations, using traps sparingly, (saturating an area with traps does not necessarily increase the probability of catching a "trap-shy" animal) and studying the habits of livestock killers in order to set traps specifically for them.

The offset-jaw type of trap also increases selectivity. When the trap closes on an animal smaller than that for which it is intended, the animal often escapes and survives (Hall 1946).

A flexible tension bar or "trigger stick" installed under the trap pan has also been used with some success to increase the selectivity of the steel trap. The tension bar allows animals below a certain weight to step on the pan without firing the trap. Adult coyotes and larger dogs continue to fire the trap by overcoming the threshold resistance of the tension bar with their heavier weight.

Tranquilizer tabs, attached to the trap, have been used experimentally with some success to reduce the animal's struggling and thereby making the trap more humane (Balser 1965).

Padding the trap jaws with burlap or pieces of rubber weatherstripping has also been used to reduce the amount of trap damage done to the foot (Swick 1971).

Extension Trapper System

The philosophy behind the Extension Trapper System is to make the farmer or rancher the control agent. Predator control specialists meet with groups of ranchers, and with the aid of a movie projector, slides, and control materials, demonstrate how they can safely and effectively deal with their own depredation problems. Following a group meeting, a field demonstration is usually held on a ranch where predators are active to show ranchers how and where to set their traps. After the field demonstration, the trapper specialist can move to other damage areas and repeat the process. Control tools are sold to ranchers at cost in order to promote the program.

The primary advantages of this program include: prompt and immediate service since the rancher has nobody to blame but himself if the job doesn't get done; greater efficiency in trapping hours per coyote caught by farmers over government trappers, due mainly to the elimination of travel time from one farm to the next; greater familiarity of a farmer with his own problem situation; and a minimal expense to the state and federal government since the burden of cost is placed upon the rancher (Cain et al. 1972, Laun 1965, and Sampson and Brohn 1955).

The effectiveness of the Extension Trapper System is directly related to the time and effort the individual farmer or rancher is willing to put into making good trap sets. Sampson and Brohn (1955) report that most farmers readily accept the challenge and noted reductions in livestock losses as high as 88 percent in some areas.

McCabe and Caroline (1970) report that the Extension System is most effective when the individual ranch or farm is small. Predator control on larger operations generally requires more time and effort than the rancher can afford. As a result, hit-and-miss attempts at control usually result in ineffective and nonselective control efforts. Evanson (1967) concludes that in eastern Missouri, where depredations are few, the system saves manpower; in the western part of the state, where coyotes are numerous and predator losses are high, the system is ineffective.

The Extension Trapper System is economical in regard to government costs, since control costs are incurred by the rancher.

The degree of selectivity achieved through extension trapping is related to the time and effort the individual landowner is willing to put into proper placement of traps.

The humaneness of Extension trapping is determined by how conscientiously ranchers follow the suggestions made by the Extension Specialist for proper placement and regular checking of traps.

M-44 (Sodium Cyanide Spring Loaded Ejector Mechanism)

The M-44 consists of a hollow, metal tube 5-9 inches long (closed by crimping at the bottom), a spring ejection mechanism, a case holder and a sodium cyanide capsule. In setting, the tube is driven full length into the ground, the ejection mechanism fitted into the top of the tube and a sodium cyanide capsule inserted into the case holder, which is wrapped with materials such as leather or wool. The finished case holder is then screwed on the top of the ejection mechanism. A fetid scent is usually smeared on the wrapping material to act as an additional lure. When the set is complete, the finished case holder, about the size of a man's thumb, protrudes above the ground and is the only visible part of the device. When the coyote grasps the case holder in its teeth and tugs, the M-44 ejects a small charge of powdered sodium cyanide directly into the animal's mouth. Cyanide acts very rapidly and since there is very little noise associated with the firing of the ejector mechanism, the coyote usually flees only a short distance before dying.

Cummings (1972) and Robinson (1943) also indicate that M-44's are more effective than traps during adverse weather conditions, when the traps may get frozen or "mudded-in". M-44's have an additional advantage over traps in that they can be placed directly in a pasture where sheep or cattle depredations are occurring, with minimal danger to these animals.

Within Montana, the M-44 is currently being used to reduce and/or prevent livestock damage by coyotes under programs supervised by the Montana State Department of Livestock and the Federal Fish and Wildlife Service, Division of Wildlife Services.

In terms of efficiency and economy, Robinson (1943) reported that a man using only M-44's could cover 60 percent more miles of line and over 40 percent more total area than with traps. During the winter months, when travel and trapping conditions are handicapped by weather, a predator control agent with M-44's could maintain 50 percent more line and cover 66 percent more area.

In terms of humane action, the M-44 is far superior to the steel trap. It produces no frightening explosion, as was the case with the coyote getter, nor does it impart physical injury with ejection. There is no pain experienced as the cyanide begins to act on the central nervous system, usually within a matter of seconds (Cummings 1972).

Bounties

The bounty system is based on the concept that the level of livestock depredations rises and falls with the population of the predatory species and that bounty payments affect these population levels. There may be some truth in the statement, but many investigators, including Wagner (1972), McCabe and Caroline (1970), Henderson (1969), Leopold (1964), Bennitt (1948), and Dixon (1920) disagree with this concept and report that bounty payments on coyotes neither reduce the total coyote population, nor the damage attributed to them. Instead, the bounty system is wasteful of non-target animals and money, encourages fraud, promotes inefficiency, and functions only as a subsidy for trappers (Cain et al. 1972, Cummings 1971, Gier 1968, Allen 1963, Gerstell 1941, and Clarke 1940).

Bounty hunters simply go where the coyotes are abundant. In most cases they are not willing to put in the time and effort necessary to catch trap-shy livestock killers. Clarke (1940) reports that bounty hunters only eliminate the young, dumb coyotes and by their actions, tend to select for the survival of wise, trap-shy individuals. The bounty system can potentially worsen a depredation problem by educating coyotes to trapping methods and making them even more difficult for a professional trapper to apprehend.

The bounty system is usually neither effective, economical, nor selective. The degree of safety and humaneness depends upon the control method being used. Bennitt (1948) reports that the main reasons for perpetuation of bounty systems are because custom dies hard, and because superficially the system appears logical.

Aerial Hunting

Aerial hunting most frequently employs small, fixed-wing aircraft or helicopters to locate coyotes. Upon locating a target, the plane may either make a low pass over the coyote, permitting the gunner to shoot the coyote with a shotgun, or the plane can act as a spotting station, coordinating the pursuit of the coyote by individuals on the ground. In either context, aerial hunting provides an efficient and effective means of locating and taking coyotes (Marsh and Bledsoe 1971, Gier 1968, and Evanson 1967).

The main advantage of aerial hunting is its selectivity for taking coyotes in depredation areas (Nesse 1974). Aerial hunts are frequently effective in eliminating the offending individual as he approaches or leaves the trouble area.

The Montana Department of Livestock has issued private aerial hunting permits since 1973 to pilots and gunners who hunt coyotes and/or foxes for the purpose of livestock protection in Montana. During 1975, a total of 45 pilots were issued aerial hunting permits. During that year they flew a total of 1,887 hours and collected 2,290 coyotes and 155 foxes (Anonymous 1976a).

Aerial hunting is a humane method of predator control, since death of the target animal usually results from shooting at close range.

Den Hunting

Den hunting is a commonly employed method of general coyote population reduction (Cain et al. 1972, Wagner 1972, Gier 1968, Evanson 1967, and Dixon 1920). Dens can be located while traveling on foot, horseback or from the air. Tracking the adults back to the den is a commonly used technique. Tracking hounds are frequently used to follow a scent trail to the den. Once the pups are extracted from the den, humane elimination can be accomplished by shooting at close range (Evanson 1967).

Although general population reduction may be of questionable benefit, elimination of coyote dens in some instances results in the abrupt termination of livestock depredations. The litter's need for food is frequently the element which forces the adult coyotes to prey on domestic livestock to supplement the natural prey species available.

Den hunting is an effective method of reducing coyote numbers (Bier 1968). Except for the hazards of crawling in holes (some extend 15 to 20 feet underground) or under rocks, den hunting is a safe method.

Sport Hunting

Sport hunting of coyotes has become a popular pastime in many parts of the country. Sport hunting usually involves either calling coyotes within range and then shooting them with a rifle or using dogs to run down and kill a coyote or chase him until he can be shot by a member of the hunting party. Leopold (1964) recommends sport hunting because it is a highly desirable form of resource use.

Calling coyotes can be a year-long sport and when conducted in areas where livestock depredations are occurring, it can prove to be an important supplementary action to other control methods being employed (Wade 1973, McCabe and Caroline 1970, Henderson 1969a, and Evanson 1967).

Hunting with hounds involves using either "sight" or "tracking" hounds (Nesse 1973). The sight hunting hounds are usually transported in pickups and released after a coyote is sighted. A greyhound or wolfhound usually overruns a coyote in a short distance. The use of sight hunting dogs is primarily limited to flat, open country. Tracking hounds are used to locate and follow a scent trail left by a coyote. The coyote is pursued until he is either run down and killed by the hounds or is shot by a member of the hunting party.

The effectiveness of hounds in controlling predator losses is directly related to the experience and quality of the dogs being used and to the proficiency of their handler.

The cost of keeping hounds is approximately $75 per year. The initial investment varies according to the experience and breeding background of the animal, but is approximately $400 per animal (Gier 1968). The cost of transporting the hounds to and from the hunting area and the expense of conducting the hunt itself, makes hound hunting a fairly expensive method of predator control.

Running hounds is a safe method of control and there is little if any danger to nontarget animals. The selectivity of the effort can be greatly enhanced by starting the hunt at the site of a fresh coyote kill.

Since most of the coyotes taken in the course of hound hunting are shot by a member of the hunting party, the animal's death is quick and, therefore, humane.

Calling and shooting, when conducted by an experienced caller, can also be an effective and economical method of predator control (Wade 1973, Henderson 1969a, Gier 1968, and Leopold 1964). When conducted in remote areas, the method is safe. Although other animals such as foxes and bobcats are frequently called in, they can be ignored in order to make the method totally selective for coyotes. Since shooting has already been discussed as a quick and humane method of eliminating coyotes, calling and shooting can, therefore, be regarded as a humane control tool.

Antifertility Agents

Antifertility agents have received considerable attention as a nonlethal method of predator control. The basic concept involves preventing animals from being born rather than reducing their numbers after they are partially or fully grown and have become established in a secure environment (Balser 1964). Elimination of the litter can also minimize a major factor contributing to the depredation problem that being the extra food requirement of the pups.

Stilbestrol initially showed the greatest promise and original field trials conducted in New Mexico in 1963 showed a potential 80 percent reduction in females capable of producing young (Balser 1964). The drop bait used for delivery contained 100 Milligrams of stilbestrol and was made from rendered beef tallow with 10 percent beeswax added to raise the melting point (Linhart et al. 1968).

The effectiveness of antifertility agents has been limited primarily because of difficulties encountered in developing a successful method of delivering the bait to the target animal. Additional problems have included destruction of baits by excessive heat or rain, removal of baits by rodents and other non-target species, and improper timing (Evanson 1967).

Attempts to increase the selectivity of stilbestrol baits have included placing the baits only in the vicinity of coyote scent stations, in specific travel trails and in the vicinity of coyote-frequented water holes (Evanson 1967). Furthermore, the breeding season of coyotes is usually earlier than that of other smaller carnivores, which allows proper timing of bait dispersal and use of selective bait carriers as more effective means of reducing the exposure to nontarget animals. Reproductive inhibitors, however, represent a general control technique and are not specific to individual killers.

The nonlethal character of antifertility agents such as stilbestrol makes them both humane and safe, even when used in agricultural areas where dogs are present.

Currently, no antifertility agents are registered for use in predator control programs in the United States. Research with reproductive inhibitors is underway at the U.S. Sheep Experiment Station at Dubois, Idaho. Preliminary trials have included: cadmium, pipecolinomethylhydioxyindane (PMHI), and alphachlorohydrin (Gates 1976). Results, although inconclusive, suggest that both cadmium and alphachlorohydrin hold little promise as effective, male coyote antifertility agents.

Predator-Proof Fencing

The logistics, economics, and feasibility of predator-proof fencing have been evaluated by numerous investigators. Early designs included a fence made of redwood stakes driven into the ground close enough together to prevent a coyote from slipping through and a heavy woven wire fence, about 52 inches tall, to prevent coyotes from jumping over (Dixon 1920).

Lantz (1905) and Jardine (1911) have described the major advantages of predator-proof fencing to be: more lambs saved from birth to weaning, better physical condition of ewes and lambs at weaning due to reduced harassment by dogs and other predators, decreased labor required for herding and observation, and reduction of predator losses. Where an individual has title to grazing land of moderate to high carrying capacity, the increases in rate of gain of stock and the decrease in handling expense during lambing, can justify initial construction costs (Jardine 1911).

In the case of smaller, predator-proof enclosures, the size of enclosure necessary to reduce livestock depredations would obviously vary according to local topography, forage conditions and size of the individual operation. Cannon (1973) reports two predator-proof enclosures in southwestern Oregon, one enclosing 1,200 acres with seven miles of fence and the other 1,500 acres with nine miles of predator-proof fencing. Following fencing, predator losses on both ranches were reduced to less than one percent per year.

The most recent coyote-proof fencing studies underway in Oregon have indicated that an effective fence for deterring coyotes should be at least 66 inches high, be constructed of mesh no larger than 6 x 4 inches, have at least a 15-inch inclined overhang, and have a woven wire apron extending at least 12 inches from the base of the fence (deCalesta 1976). Cost per mile for materials to construct such a fence is estimated at $2,500.

The main disadvantages of predator-proof enclosures include incomplete utilization of available rangeland due to restricted foraging of animals traveling to and from an enclosure each evening, over-utilization of forage near the enclosure, weight loss from ewes and lambs caused by excessive traveling to and from an enclosure, mothering complications resulting from separation of ewes and lambs while confined within small enclosures, unwillingness of certain sheep breeds to return to an enclosure each evening, and the added expense of building the enclosure.

Under certain circumstances, predator-proof fencing has been effective in reducing livestock depredation by coyotes (Cannon 1973). Ranchers in Wyoming and Texas have used coyote fencing to protect vulnerable, valuable lambing areas (Cummings 1971). The primary limitations have been construction costs and the impracticality of substantial fencing expenses on leased range agreements.

Since fencing is a form of nonlethal control, it is both safe and humane. It is also a selective deterrent against those coyotes involved in livestock depredations.

Repellents

Repellents which act upon a predator's sense of smell, hearing and sight have been used in attempts to prevent coyotes from attacking domestic livestock (Nesse 1973, 1971), and (Cummings 1971). Gas-operated carbide guns, lanterns, and revolving lights have all been used to try to frighten coyotes away from livestock production areas (Nesse 1976). Ranchers have reported that these devices may be effective for a short while, but that coyotes soon adjust to the disturbance and resume their normal activity patterns.

Nesse (1971) reported that odor repellents may be effective in preventing livestock depredations by coyotes and feral dogs. Field studies conducted with the Gerhardi Livestock Protector, a ventilated ear capsule filled with artificial skunk odor, resulted in some protection to the study animals. Odor repellents, such as the Gerhardi Protector, however, are considered an adjunct to, but not a replacement for, conventional means of predator control.

Aversive conditioning studies using lithium chloride have also been conducted. Preliminary results suggest that certain coyotes may be temporarily trained not to kill sheep (Gustavson 1974). Lamb meat laced with lithium chloride, for example, was fed to coyotes and following intestinal disorders induced by the lithium chloride, the same coyotes refused to kill lambs. Prior to lithium chloride illness, these coyotes readily attacked and killed lambs.

Repellent studies currently underway include investigations of the extract of bitter sneezweed, cinnamaldehyde, and oil of mustard (Cringhan 1976). Some olfactory and gustatory results have been observed, but on the basis of evidence presently available it seems unlikely that these compounds will afford any significant solution to the problem.

Predator-Loss Insurance

Insurance policies to cover predator losses, or those to cover losses to all causes, have been discussed by several investigators (Wagner 1972, Cain et al. 1972, and McCabe and Kozicky 1972). Recommendations have included payment programs ranging from reimbursement to sheepmen for predator losses in excess of a pre-determined county or state average predation rate, to reimbursement of ranchers for losses to any and all causes which are in excess of a predetermined "reasonable" loss rate. Annual premiums, according to Wagner (1972), could be adjusted so as to favor sheepmen with low predator losses and be somewhat higher for those individuals who have a chronic depredation problem. The premium acts, in this context, as somewhat of a financial reward to the supposed "better" operator.

The predator insurance idea is an alternative worthy of careful evaluation. There are several factors which must be carefully considered. First, an insurance policy does nothing to curtail losses. Second, there has been considerable speculation about what predator losses would be if all control was abolished. It seems reasonable to assume that the level of predator losses would not remain at present levels, but would probably increase, if control activities were terminated.

Third, Nesse (1976) and Bouns et al. (1973), have indicated that certain sheepmen face chronic depredation problems because of the area in which they operate. Sheepmen who operate foothill rangelands contiguous to National Forest lands, for example, may incur heavier losses than sheepmen whose operations are located in more protected valley areas. In such instances, the foothill operators can act as a buffer between the more favorable predator habitat within the forest boundaries and the more populated, agricultural land along the valley floor. Because of their more vulnerable location, a few operators may absorb most of the predator losses. Considerably more information is needed about the many biological and ecological factors which interact to create a depredation problem before any serious efforts are undertaken to initiate an effective insurance program.

Comparative Costs of Control Methods

According to operating cost data compiled within Montana during 1975 by the Montana Department of Livestock, the average cost per coyote or fox taken using mechanical control methods, including traps and snares, was $200 per animal. The cost per animal taken using M-44's was $19.32, excluding salaries and travel expenses. The average costs to take a coyote or fox by the state owned and operated helicopter or contracted fixed-wing aircraft were $45 and $25 per animal, respectively (Seyler 1975). Differential cost data are important when evaluating the economic feasibility of implementing various control strategies to aid in reducing or preventing livestock losses to coyotes.

APPENDIX II

1080 PROJECT GUIDANCE COMMITTEE

A 1080 Project Guidance Committee will be established to guarantee study continuity and funding, supervise the selecting of research personnel, assist in the planning and development of field and laboratory operations, and coordinate the dissemination of information to all Federal, State, and local agencies or organizations. The Guidance Committee will be comprised of representatives from the Montana Departments of: Health and Environmental Sciences, Agriculture, Fish and Game, Livestock, the State University System and the Environmental Protection Agency. Ex-Officio representatives from the U.S. Fish and Wildlife Service, Governor's Office, the Environmental Quality Council, and possibly others will be included.

Pending funding arrangements, the Guidance Committee will hire a full-time project leader to supervise all phases of these proposed investigations. Research personnel, again depending upon funding levels, may range from students engaged in graduate studies at the University of Montana or Montana State University to full-time research biologists.

APPENDIX III

USE PRECAUTIONS FOR SINGLE, LETHAL 1080 BAITS

USE PRECAUTIONS FOR SINGLE, LETHAL 1080 BAITS

Throughout the duration of these proposed investigations, the utilization of single, lethal 1080 baits shall be restricted so as not to endanger the general public, domestic animals, or nontarget wildlife, including rare and endangered or threatened species. The selection of study areas will be confined to sparsely inhabited areas. Adjacent landowners to proposed study areas will be contacted or otherwise notified that predator control operations utilizing single, lethal 1080 baits will be conducted on specified land areas designated by section, township and range. Following is a list of specific use precautions that will be implemented during the entire course of these investigations:

1. Single, lethal 1080 baits shall not be placed within ¼ mile of any occupied dwelling without written permission from the occupant.
2. Single, lethal 1080 baits will not be set within ½ mile of any public right-of-way.
3. Single, lethal 1080 baits will not be placed within 25 feet of any carcass or portion thereof, of any big game, small game, game bird, non-game bird, furbearer, fish, or other wildlife.
4. No more than two single, lethal 1080 baits may be placed at any one placement location.
5. No more than 10 single, lethal 1080 baits will be placed per square mile.
6. Single, lethal 1080 baits may not be placed within 100 feet of any lake, stream, center of water course, or water supply well.

7. Warning signs will be prominently displayed at the entrances of all roads and trails leading to those areas where single, lethal 1080 baits have been placed, at commonly used access points, and at other locations necessary to safeguard the public.

8. Stake warning signs must be placed within 10 feet of any single, lethal 1080 baits and elevated at least 15 inches off the soil surface.

9. At least two members of the research staff shall be aware of the location of all single, lethal 1080 baits.

10. All 1080 concentrate shall be stored and transported only in properly labeled containers and held under lock at all times except during the treatment of bait materials.

11. All single, lethal 1080 baits placed within the experimental area will be checked by research personnel at intervals not to exceed seven days throughout the duration of the investigation.

12. Respirators, protective clothing and gloves will be worn at all times when handling 1080 concentrate. Gloves will be worn when distributing baits.

13. Under no circumstances will research personnel transfer possession of 1080 concentrate, solutions or treated baits to unauthorized individuals.

14. Written permission will be obtained from each landowner, administrator, or leasee within the proposed study areas before single, lethal 1080 baits will be placed on their property.

15. Written records shall be kept by research personnel including placement locations, date of placement, number of baits placed, date baits checked, consumption of baits by target or nontarget animals, environmental effects on baits, dates baits retrieved, and destruction of baits.

16. All 1080 baits shall be transported in covered, locked, leakproof containers to prevent accidental exposure to any person or nontarget animal.

17. Protective natural coverings such as cow chips, small stones, vegetative debris, or other objects will be used to prevent baits from being seen and taken by scavenging or other nontarget birds.

18. All uneaten or excess single, lethal 1080 baits will be destroyed by burning by research personnel. The ashes will be buried following contamination with lime, creosote, or other repellent material to prevent excavation by dogs or other scavengers.

19. Thorough washing of hands after bait formulation and handling of treated baits with gloves will be practiced by research personnel.

20. No single, lethal 1080 baits will be placed within prairie dog towns. This protective measure taken to reduce the potential exposure hazard of these baits to prairie dogs and black-footed ferrets.

21. No single, lethal 1080 baits will be placed on land areas in Montana designated by any state or federal agency as occupied habitat for the wolf or grizzly bear.

22. Single, lethal 1080 baits will be placed in open clearings at least 75 yards from any protective vegetation in areas where marten sign have been identified.

23. Single, lethal 1080 bait placement locations shall be located at least ¼ mile apart.

24. All single, lethal 1080 baits will be retrieved from a livestock and/or big game depredation area following the termination of losses for 30 days.

APPENDIX IV

PROPOSED BUDGET

1080 SINGLE, LETHAL BAIT INVESTIGATIONS

BUDGET

1080 SINGLE LETHAL BAIT INVESTIGATIONS

Damage Abatement and Coyote Population Control

Salaries and Wages	1st Year	2nd Year	3rd Year
Project Leader	$ 15,000	$ 15,750	$ 16,537
Graduate Students:			
1 Ph.D. - full-time field work for duration of project	9,000	9,450	9,922
2 M.S. - ½ length of project each	3,600	3,780	3,969
Technician - ½ time	5,500	5,775	6,064
Secretarial help - ½ time	3,800	3,990	4,190
Fringe Benefits			
14% for Project Leader and Technician	2,870	3,013	3,164
7% for graduate students	882	926	972
Supplies and Equipment			
Sodium Monofluoroacetate (43.2 grams @ $4.50/gm	194	205	215
Bait materials (400 lbs @ .50/lb)	200	210	220
Trapping and Other Supplies: 2 spotlights bait preparation containers gloves and protective clothing 2 sirens binoculars spotting scopes live traps and other traps tags and collars drugs (tranquilizers, etc.)	5,000	2,500	2,500

BUDGET (continued)

Travel and Per Diem	1st Year	2nd Year	3rd Year
Purchase 2 pickups	$ 12,000	-	-
2 vehicles @ 100 mi./veh./day			
200 days @ 200 mi./day = 40,000 mi.			
40,000 mi. @ 10 mi./gal.			
4,000 gal. @ .60/gal.	2,400	2,640	2,904
Maintenance and upkeep	1,000	1,000	1,000
12 trips by Project Leader to study areas			
20,000 mi. @ 16½¢/mi. (4x4)	3,300	3,300	3,300
Per diem (all personnel)	4,000	4,000	4,000
Out-of-state travel	1,000	1,000	1,000
Rent			
Purchase 1 trailer and provide upkeep	3,000	1,000	1,000
Contracted Services			
Printing	300	300	1,000
Statisticians and computer time	1,000	1,000	2,000
Laboratory Analysis (Samples)	5,000	5,000	5,000
Communications			
Freight	200	200	200
Postage	200	200	200
Phone	1,800	1,800	1,800
Utilities			
Gas and electricity	300	350	400
Aerial Reconnaisance			
30 hrs/mo. x 12 mos. = 360 hrs/yr.			
240 @ 40/hr. (fixed wing)	9,600	9,600	9,600
120 @ 150/hr. (helicopter)	18,000	18,000	18,000

BUDGET (Continued)

*Livestock Reimbursement	1st Year	2nd Year	3rd Year
300 lambs /yr. @ $50 ea.	$ 15,000	$ 15,000	$ 15,000
30 ewes/yr. @ $50 ea.	1,500	1,500	1,500
30 calves/yr. @ $100 ea.	3,000	3,000	3,000
Annual Totals	$128,646	$114,489	$118,657
3 Year Project TOTAL	$361,792		

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* Livestock loss rates may fluctuate greatly, therefore adjustments may be required.

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